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REFERENCES

1. D2-7850 Section 7 - <u>Destruct Package Installation Facility DPIF</u>.

2. 24-2188 - <u>M&IR Data Sheets for E-I Survey DPIF #1</u>.

3. 24-2187 - <u>M&IR Data Sheets for E-I Survey DPIF #2</u>.

4. <u>Instruction Manual, Noise and Field Intensity Meter, Model NF-105</u>.

5. <u>Instruction Manual, Tuning Unit, 14 KC to 150 KC, Model T-X/NF-105</u>.

6. <u>Instruction Manual, Tuning Unit, 150 KC to 30 MC, Model T-A/NF-105</u>.

7. <u>Instruction Book for Model NM-20B Radio Interference and Intensity Meter</u>.

8. Edward D. Jordan, <u>Electromagnetic Wave and Radiating Systems</u>, Prentice-Hall Inc. New York, 1950.

9. Frederick E. Terman, <u>Electronic and Radio Engineering</u>, McGraw-Hill Book Company Inc., New York, Toronto, London, 1955.

10. John D. Kranus, <u>Antennas</u>, McGraw-Hill Book Company Inc., New York, Toronto, London, 1950.

11. Hugh H. Skilling, <u>Electric Transmission Lines</u>, McGraw-Hill Book Company Inc., New York, Toronto, London, 1951.

12. Sprague Technical Paper No. 62-1, <u>Interference Control Techniques</u>, Sprague Electric Company, North Adams, Massachusetts.

ADMINISTRATIVE DATA

PURPOSE OF ANALYSIS	The purpose of this analysis is to show that the ambient electric fields present in the DPIF's are not of sufficient magnitude to cause inadvertant squib firings.
MANUFACTURER:	Not applicable
MANUFACTURER'S TYPE OR MODEL NO.:	Not applicable
DRAWING, SPECIFICATION OR EXHIBIT:	Not applicable
QUANTITY OF ITEMS ANALYZED:	(2), DPIF #1 and DPIF #2
SECURITY CLASSIFICATION OF ITEMS:	Not applicable
DATE ANALYSIS COMPLETED	December 26, 1962
ANALYSIS PERFORMED BY:	R. J. Gower
DISPOSITION OF SPECIMENS:	Not applicable
ABSTRACT:	This report described the analysis performed per D2-7850 (Electro-Interference Test Plan for the WS-133A System Vandenberg AFB Complex MAD) Section 7 (Destruct Package Installation Facility, DPIF). Data on Electro-Interference levels present in the DPIF's was taken from MAIR Data Sheets, Drawing Numbers 24-2187 and 24-2188 and converted to Electric Field Intensity levels. Broadband voltage levels were converted to equivalent CW levels and the converted broadband and CW levels were then compared with the voltage levels calculated necessary to produce 100 milliamperes through a squib. The results show that the fields present in the DPIF's are not of sufficient magnitude to induce 100 milliamperes in the squib circuits. "Worst case" assumptions are made in all cases.

1.0 RADIATED R-I LEVELS PRESENT IN THE DPIF #1

The ambient R-I levels existing in the DPIF #1 were determined by Test Number ST-52. The measurements obtained during this test are contained in Reference 2, "MAIR Data Sheets, Drawing Number 24-2188." In order to obtain "worse case" conditions, the maximum measurements made at the G&C or Skirt Areas, day or night, will be considered. These maximum measurements are listed in Table I, page 22 and Table IV, page 25.

1.1 Conversion to Field Intensity Levels

Because the text and equations contained in Reference 1, "D2-7850 Section 7," have been presented in terms of field intensity, the maximum readings obtained from Reference 2, "MAIR Data Sheets, Drawing Number 24-2188", must also be presented in terms of field intensity.

1.1.1 Radiated CW Conversion

Direct Radiated CW measurements made with a Noise and Field Intensity Meter, NF-105, may be converted to field intensity levels in the following manner:

E [db above 1 microvolt/meter] = Meter Reading [db above 1 microvolt] + Meter Attenuation [db] + Cable Loss Factor [db] + Antenna Mismatch Factor [db] + Open Circuit Conversion Factor [db] + Antenna Effective Length Factor [db] .

When the NF-105 is used to make measurements from 20 MC to 1000 MC with a T-1, T-2, or T-3 head, the cable loss, antenna mismatch, open circuit conversion, and antenna effective length factors may be lumped together and considered as one factor as shown in Figure 9 of Reference 4, "Noise and Field Intensity Meter, Model NF-105".

When the NF-105 is used to make measurements from 150 KC to 30 MC with a T-A head, the cable loss, antenna mismatch, and open circuit conversion factors may be lumped together and considered as one factor as shown in Figure 4 of Reference 6, "Instruction Manual, Tuning Unit, 150 KC to 30 MC, Model T-A/NF-105". The effective length factor for the rod antenna is 6 db.

Table I, page 22, gives a listing of these conversions. The resultant field intensity levels are shown in Figure I, page 29.

1.0 **RADIATED E-I LEVELS PRESENT IN THE DPIF #1** (continued)

1.1.2 **Radiated Broadband Conversion**

Radiated Broadband measurements made with a Noise and Field Intensity Meter, NF-105, by using the substitution method, may be converted to field intensity levels in the following manner:

E [db above 1 microvolt/megacycle/meter] = Total Impulse Generator Input [db above 1 microvolt/megacycle] + Cable Loss Factor [db] + Antenna Mismatch Factor [db] + Open Circuit Conversion Factor [db] + Effective Length Factor [db] .

When the NF-105 is used to make measurements from 20 MC to 1000 MC with a T-1, T-2, or T-3 head, the cable loss, antenna mismatch, open circuit conversion and antenna effective length factors may be lumped together and considered as one factor as shown in Figure 9 of Reference 4, "Noise and Field Intensity Meter, Model NF-105".

When the NF-105 is used to make measurements from 150 KC to 30 MC with a T-A head, the cable loss, antenna mismatch, and open circuit conversion factors may be lumped together and considered as 20 db plus the factor shown in Figure 4 of Reference 6, "Instruction Manual Tuning Unit, 150 KC to 30 MC, Model T-A/NF-105". The effective length factor for the rod antenna is 6 db.

When the NF-105 is used to make measurements from 14 KC to 150 KC with a T-X head, the cable loss, antenna mismatch, and open circuit conversion factors may be lumped together and considered as 20 db plus the factor shown in Figure 6 of Reference 5, "Instruction Manual, Tuning Unit, 14 KC to 150 KC, Model T-X/NF-105". The effective length factor for the rod antenna is 6 db.

Table IV, page 25 gives a listing of these conversions. The resultant field intensity levels are shown in Figure I, page 29.

2.0 **RADIATED E-I LEVELS PRESENT IN THE DPIF #2**

The ambient E-I levels existing in the DPIF #2 were determined by Test Number ST-60. The measurements obtained during this test are contained in Reference 3, "M&IR Data Sheets, Drawing Number 24-2187". In order to obtain "worse case" conditions the maximum measurements made at the G&C or Skirt Areas, day or night, will be considered. These maximum measurements are listed in Table II page 23, Table III page 24, Table V page 27, and Table VI page 28.

2.1 **Conversion to Field Intensity Levels**

Because the text and equations contained in Reference 1, "D2-7850 Section 7", have been presented in terms of field intensity the maximum readings obtained from Reference 3, "M&IR Data Sheets, Drawing Number 24-2187", must also be presented in terms of field intensity.

2.1.1 **Radiated CW Conversion**

Direct Radiated CW measurements made with a Noise and Field Intensity Meter, NF-105, may be converted to field intensity levels in the following manner:

E [db above 1 microvolt/meter] = Meter Reading [db above 1 microvolt] + Meter Attenuation [db] + Cable Loss Factor [db] + Antenna Mismatch Factor [db] + Open Circuit Conversion Factor [db] + Antenna Effective Length Factor [db].

When the NF-105 is used to make measurements from 20 MC to 1000 MC with a T-1, T-2, or T-3 head, the cable loss, antenna mismatch, open circuit conversion and antenna effective length factors may be lumped together and considered as one factor as shown in Figure 9 of Reference 4, "Noise and Field Intensity Meter, Model NF-105".

When the NF-105 is used to make measurements from 150 KC to 30 MC with a T-A head, the Cable Loss, antenna mismatch, and open circuit conversion factors may be lumped together and considered as one factor as shown in Figure 4 of Reference 6, "Instruction Manual, Tuning Unit, 150 KC to 30 MC, Model T-A/NF-105. The effective length factor for the rod antenna is 6 db.

2.0 **RADIATED E-I LEVELS PRESENT IN THE DPIF #2** (continued)

2.1.1 **Radiated CW Conversion** (continued)

Table II page 23 gives a listing of these conversions. The resultant field intensity levels are shown in Figure II, page 30 .

Direct CW measurements made with a Radio Interference and Intensity Meter, NM-20B, may be converted to field intensity levels in the following manner:

E [db above 1 microvolt/meter] = Meter Reading [db above 1 microvolt] + Meter Attenuation [db] + Effective Length Factor [db] .

This is discussed in Reference 6, "Instruction Book for Model NM-20B Radio Interference and Intensity Meter". Table III gives a listing of these conversions. The resultant field intensity levels are shown in Figure II.

2.1.2 **Radiated Broadband Conversion**

Radiated Broadband measurements made with a Noise and Field Intensity Meter, NF-105, by using the substitution method may be converted to field intensity levels in the following manner:

E [db above 1 microvolt/megacycle/meter] = Total Impulse Generator Input [db above 1 microvolt/megacycle] + Cable Loss Factor [db] + Antenna Mismatch Factor [db] + Open Circuit Conversion Factor [db] + Effective Length Factor [db] .

When the NF-105 is used to make measurements from 20 MC to 1000 MC with a T-1, T-2, or T-3 head, the cable loss, antenna mismatch, open circuit conversion, and antenna effective length factors may be lumped together and considered as one factor as shown in Figure 9 of Reference 4, "Noise and Field Intensity Meter, Model NF-105".

When the NF-105 is used to make measurements from 150 KC to 30 MC with a T-A head, the cable loss, antenna mismatch, and open circuit conversion factors may be lumped together and considered as 20 db plus the factor shown in Figure 4 of Referenc 6, "Instruction Manual, Tuning Unit, 150 KC to 30 MC, Mode T-A/NF-105". The effective length facter for the rod antenna is 6 db.

2.0 RADIATED E-I LEVELS PRESENT IN THE DPIF #2 (continued)

2.1.2 Radiated Broadband Conversion (continued)

When the NF-105 is used to make measurements from 14 KC to 150 KC with a T-X head, the cable loss, antenna mismatch, and open circuit conversion factors may be lumped together and considered as 20 db plus the factor shown in Figure 6 of Reference 5, "Instruction Manual, Tuning Unit 14 KC to 150 KC, Model T-X/NF-105". The effective length factor for the rod antenna is 6 db.

Table V, page 27 gives a listing of these conversions. The resultand field intensity levels are shown in Figure II, page 30 .

Direct Broadband measurements made with a Radio Interference and Intensity Meter, NM-20B, may be converted to field intensity levels in the following manner:

E [db above 1 microvolt/megacycle/meter]
= Meter Reading [db above 1 microvolt/meter bandwidth] + Meter Attenuation [db] + Bandwidth Factor [db] + Effective Length Factor [db] .

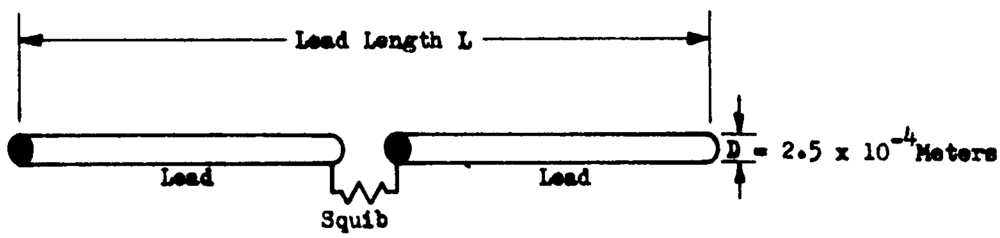
This is discussed in Reference 6, "Instruction Book for Model NM-20B Radio Interference and Intensity Meter". Table VI gives a listing of these conversions. The resultant field intensity levels are shown in Figure II.

3.0 MINIMUM FIELD INTENSITY REQUIRED TO INDUCE 100 MILLIAMPS IN SQUIB CIRCUITS

The minimum field intensity levels required to induce 100 milliamps in the squib circuits will be calculated using basic dipole theory as shown in Reference 1, "D2-7850 Section 7". Assumptions leading to "worse case" conditions will be made in all cases. The resultant minimum field intensity levels required to induce 100 milliamps in the squib circuits are shown in Figure I and Figure II.

3.1 Dipole Analogy of Squib Circuits

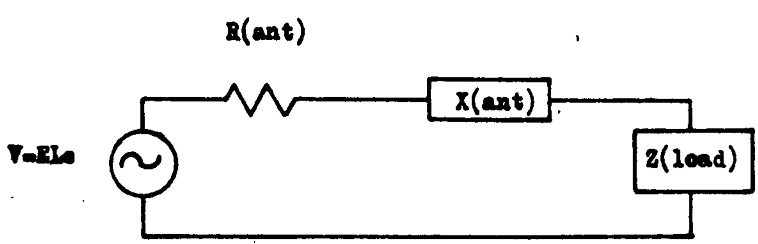
The assumptions made in Reference 1, "D2-7850 Section 7", will be made in this report. The squibs and their leads (twisted shielded pairs) will be assumed to form dipoles and their leads. Any attenuation caused by the twisting and shielding of the leads or the leads orientation and proximity to nearby metallic structures will be neglected to give a "worse case" condition. The circuit will be assumed to be of a configuration as shown in the sketch below.



Where D = diameter of #10 wire.

3.2 Antenna Equivalent Circuit

Shown in the sketch below is a Thevenin equivalent circuit of a dipole antenna with open circuit voltage V.



3.0 **MINIMUM FIELD INTENSITY REQUIRED TO INDUCE 100 MILLIAMPS IN SQUIB CIRCUITS (continued)**

3.2 **Antenna Equivalent Circuit (continued)**

where:

E = Field Intensity
Le = Effective Length of Antenna
R (ant) = Total Resistance of Antenna
X (ant) = Reactance of Antenna
Z (lead) = Impedance of Lead

3.3 **Antenna Reactance**

For a given antenna length Le, R(ant), and X(ant) are functions of the frequency of the impinging electromagnetic wave (see chapter 10 and 15 of Reference 7). The reactance of a center fed dipole is cyclic with frequency being highly capacitive until L/λ (where λ is the wavelength of the impinging wave) approaches approximately .48 where the total reactance is zero, inductive for $.48 < L/\lambda < .89$, capacitive for $.89 < L/\lambda < 1.46$, and so forth.

3.4 **Dipoles of Length L Greater than $.48\lambda$.**

Field intensity levels required to induce 100 milliamps in the squib circuits will be calculated for short dipoles ($L/\lambda < .48$), but a simplifying assumption leading to a worse case analysis will be made for long dipoles ($L/\lambda > .48$).

For dipoles where $L/\lambda > .48$ it will be assumed that the antenna is made up of N number (N being any number, whole or decimal, greater than one) of resonant half wave dipoles ($L/\lambda = .48$). The power delivered to the squib by the long dipole will be N times the amount of power delivered to the squib by a resonant half wave dipole. This is the same assumption made in Reference 1, "D2-7850 Section 7," except it neglects the effects of antenna reactance encountered when $L/\lambda \neq$ some integer multiple of .48. As can be seen from the Thevenin equivalent circuit of a dipole (Page 14), antenna reactance will decrease the amount of current flowing through the squib. Thus, neglecting antenna reactance when $L/\lambda > .48$ we are assuming that more current will be induced in the squib circuit than would be the actual case. Also, as seen in Reference 9, "Electronic and Radio Engineering, Chapter 23," a long dipole consisting of N number of resonant dipoles will deliver considerably less than N times the amount of power that a resonant dipole delivers.

3.0 **MINIMUM FIELD INTENSITY REQUIRED TO INDUCE 100 MILLIAMPS IN SQUIB CIRCUITS (continued)**

3.5 **Maximum Squib Lead Length**

When the missiles are in the DPIFs, the ordnance Safe and Arm devices are in the "Safe" position. In the "Safe" position, the Safe and Arm devices interrupt the squib circuits, provide dummy leads for the squib firing circuits, and limit the squib lead lengths to that of the lengths of the wires running from the Safe and Arm devices to the squibs. The longest squib lead length occurs in a squib circuit that does not have a Safe and Arm device, the Second Stage Battery Activation circuit. In this circuit the squib leads originate in the Skirt Umbilical connector and run to the Second Stage Battery Activation device, traveling approximately 33.5 feet. The maximum squib lead length, L, is:

L = 33.5 feet/lead x 2 leads = 67 feet = 20.4 meters

3.6 **Calculations of Minimum Field Intensity Levels**

Minimum field intensity levels required to induce 100 milliamps in the squib circuits will be calculated in the manner explained in Reference 1, "D2-7850 Section 7". The squib circuits will be assumed to:

(1) form a resonant dipole from 6 MC to 1000 MC.
(2) form a 24 meter dipole.
(3) form a 20.4 meter dipole.
(4) form a 14.4 meter dipole.
(5) form a 1.44 meter dipole.

The equations to be used when calculating the minimum field intensity levels required to induce 100 milliamps in the squib circuits have been taken from Reference 1, "D2-7850 Section 7", and are as follows:

$$V = E L_e$$
$$R_r = 20\pi^2 \; (L/\lambda)^2$$
$$X_a = -120 \left[\ln(L/D) - 1 \right] \; \cot(\pi L/\lambda)$$

where:

V = Open Circuit Antenna Induced Voltage
E = Field Intensity
Le = Effective Length of Antenna
Rr = Radiation Resistance
L = Physical Length of Antenna
λ = Wavelength of the Frequency Concerned
Xa = Antenna Reactance
D = Diameter of Antenna = 2.5×10^{-4} meters

3.0 MINIMUM FIELD INTENSITY REQUIRED TO INDUCE 100 MILLIAMPS IN SQUIB CIRCUITS (continued)

3.6 Calculations of Minimum Field Intensity Levels (continued)

Using these equations and effective length relationships as published in Reference 8, "Electromagnetic Waves and Radiating Systems, Chapter 10," the minimum field intensity levels required to induce 100 milliamps in the squib circuits will be calculated for the particular cases stated. The squib resistance, although negligible when compared to the impedance of the antenna, will be assumed to be 0.1 ohm.

3.6.1 $L = .48\lambda$ (Resonant Dipole) From 6 MC to 1000 MC

Assuming the squib leads to form resonant dipoles in the frequency range of 6 MC to 1000 MC, the minimum field intensity levels required to induce 100 milliamps in the squib circuits will be calculated at various frequencies.

$Rr = 66.5$ ohms

(a) Total impedance = $Rr + R$ (lead) = 66.6 ohms
(b) $V = Zt\ I = (66.6)(.100) = 6.66$ Volts
(c) Le at resonance = $.3\lambda$
(d) $E = V/Le = \frac{6.66}{.3\lambda} = 22.2/\lambda$ volts per meter

$$\lambda = \frac{c}{f} = \frac{300 \times 10^6}{f}$$

$$E = \frac{22.2f}{300 \times 10^6} = .074\ f \text{ micro volts per meter}$$

(e) E [db above 1 micro volt per meter] = 20 log (.074f). Substituting various values of f give the following results:

f (cps)	E (db above 1 microvolt/meter)
6×10^6	113
7.05×10^6	114
10^7	117
10^8	137
10^9	157

3.0 **MINIMUM FIELD INTENSITY REQUIRED TO INDUCE 100 MILLIAMPS IN SQUIB CIRCUITS** (continued)

3.6 **Calculations of Minimum Field Intensity Levels** (continued)

Using these equations and effective length relationships as published in Reference 8, "Electromagnetic Waves and Radiating Systems, Chapter 10", the minimum field intensity levels required to induce 100 milliamps in the squib circuits will be calculated for the particular cases stated. The squib resistance, although negligible when compared to the impedance of the antenna, will be assumed to be 0.1 ohm.

3.6.1 **L = .48λ (Resonant Dipole) From 6 MC to 1000 MC**

Assuming the squib leads to form resonant dipoles in the frequency range of 6 MC to 1000 MC, the minimum field intensity levels required to induce 100 milliamps in the squib circuits will be calculated at various frequencies.

$Rr = 66.5$ ohms

(a) Total impedance = $Rr + R(\text{lead}) = 66.6$ ohms
(b) $V = Zt\, I = (66.6)(.100) = 6.66$ Volts
(c) Le at resonance = $.3\lambda$
(d) $E = V/Le = \dfrac{6.66}{.3\lambda} = 22.2/\lambda$ volts per meter

$$\lambda = \frac{c}{f} = \frac{300 \times 10^6}{f}$$

$$E = \frac{22.2f}{300 \times 10^6} = .074\, f \text{ micro volts per meter}$$

(e) E [db above 1 micro volt per meter] = $20 \log (.074f)$. Substituting various values of f give the following results:

f (cps)	E (db above 1 microvolt/meter)
6×10^6	113
7.05×10^6	114
10^7	117
10^8	137
10^9	157

3.0 MINIMUM FIELD INTENSITY REQUIRED TO INDUCE 100 MILLIAMPS IN SQUIB CIRCUITS (continued)

3.6.2 L = 24 Meters

Assuming a squib lead length of 24 meters, the minimum field intensity levels required to induce 100 milliamps in the squib circuits will be calculated at various frequencies. The following steps will be taken:

(1) Calculate the length (Lr) of a resonant half wave dipole at a given frequency.

$$Lr = .48\lambda = .48\ C/f$$

(2) For values of L > Lr determine how many resonant half wave dipoles (N) the long dipole consists of for each frequency.

$$N = L/Lr$$

(3) For values of L > Lr determine the gain (G) of the long dipole over the resonant half wave dipole.

$$G\ [db] = 10 \log_{10} N$$

(4) For values of L > Lr determine the minimum field intensity in db required to induce 100 milliamps in the squib circuits for each frequency.

$$E[\text{db above 1 microvolt/meter}] = E(\text{min. for resonant half wave dipole}) - G$$

(5) For values of L < Lr determine the radiation resistance (Rr)

$$Rr = 20\pi^2 (L/\lambda)^2$$

(6) For values of L < Lr determine the antenna reactance (Xa).

$$Xa = -120\ [\ln (L/D) -1]\ \text{Cot}\ (\pi L/\lambda)$$

(7) For values of L < Lr determine the open circuit voltage (V) required to induce 100 milliamps in the squib circuits.

$$V = IZ_T = I\ (R(\text{squib}) + Rr + j\ Xa)$$

3.0 MINIMUM FIELD INTENSITY REQUIRED TO INDUCE 100 MILLIAMPS IN SQUIB CIRCUITS (continued)

3.6.2 L = 24 Meters (continued)

(8) For values of L < Lr determine the field intensity (E), in terms of db, required to induce 100 milliamps in the squib circuits.

$$E\left[\text{db above 1 microvolt/meter}\right] = 20 \log V/Le \simeq 20 \log V/.5L$$

For Values of L > Lr				
f (cps)	Lr (meters)	N	G (db)	E (db above 1 microvolt/meter)
6×10^6	24	1	0	113
10^7	14.4	1.67	2	115
10^8	1.44	16.7	12	125
10^9	.144	167	22	135

For Values of L < Lr				
f (cps)	Rr (ohms)	Xa (ohms)	V (volts)	E (db above 1 micro-volt/meter)
10^4	.00013	505,000	50,500	193
10^5	.013	50,200	5,020	173
10^6	1.3	4,900	490	152
5×10^6	32	410	41	131

3.6.3 L = 20.4 Meters

Assuming a squib lead length of 20.4 meters, the minimum field intensity required to induce 100 milliamps in the squib circuits will be calculated at various frequencies. Calculations will be performed in the same manner as in paragraph 3.6.2.

For Values of L > Lr				
f (cps)	Lr (meters)	N	G (db)	E (db above 1 microvolt/meter)
7.05×10^6	20.4	1	0	114
10^7	14.4	1.42	1	116
10^8	1.44	14.2	11	126
10^9	.144	142	21	136

3.0 <u>MINIMUM FIELD INTENSITY REQUIRED TO INDUCE 100 MILLIAMPS IN SQUIB CIRCUITS</u> (continued)

3.6.3 <u>L = 20.4 Meters</u> (continued)

For Values of L < Lr				
f (cps)	Rr (ohms)	Xa (ohms)	V (volts)	E (db above 1 microvolt/meter)
10^4	.00009	527,000	52,700	194
10^5	.009	57,100	5,710	175
10^6	.9	5,180	518	154
5.9×10^6	32	394	40	132

3.6.4 <u>L = 14.4 Meters</u>

Assuming a squib lead length of 14.4 meters, the minimum field intensity required to induce 100 milliamps in the squib circuits will be calculated at various frequencies. Calculations will be performed in the same manner as in paragraph 3.6.2.

For Values of L > Lr				
f (cps)	Lr (meters)	N	G (db)	E (db above 1 microvolt/meter)
10^7	14.4	1	0	117
10^8	1.44	10	10	127
10^9	.144	100	20	137

For Values of L < Lr				
f (cps)	Rr (ohms)	Xa (ohms)	V (volts)	E (db above 1 micro-volt/meter)
10^4	.0000455	792,000	79,200	201
10^5	.00455	79,200	7,920	181
10^6	.455	7,860	786	161
5×10^6	11.4	1,270	127	145
8.34×10^6	32	385	38.6	135

3.6.5 <u>L = 1.44 Meters</u>

Assuming a squib lead length of 1.44 meters, the minimum field intensity required to induce 100 milliamps in the squib circuits will be calculated at various frequencies. Calculations will be performed in the same manner as in paragraph 3.6.2.

3.0 MINIMUM FIELD INTENSITY REQUIRED TO INDUCE 100 MILLIAMPS IN SQUIB CIRCUITS (continued)

3.6.5 L = 1.44 Meters (continued)

For Values of L > Lr

f (cps)	Lr (meters)	N	G (db)	E (db above 1 microvolt/meter)
10^8	1.44	1	0	137
10^9	.144	10	10	147

For Values of L < Lr

f (cps)	Rr (ohms)	Xa (ohms)	V (volts)	E (db above 1 micro-volt/meter)
10^4	.000000455	6,100,000	610,000	239
10^5	.0000455	610,000	61,000	219
10^6	.00455	60,900	6,090	199
10^7	.455	6,050	605	178
$5x10^7$	11.4	979	97.9	163
$8.34x10^7$	32	296	29.8	152

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TABLE I

Maximum CW E-I Readings Taken With an NF-105 at the DPIF #1 And Their Corresponding Field Intensity Levels.

Frequency (megacycles)	Meter Reading (db above 1 microvolt)	Meter Attenuation (db)	Correction Factors (db)	E (db above 1 microvolt/meter)
.52	13	30	18	61
.575	8	30	19	57
.69	10	40	20	70
.92	8	40	17	65
.96	17	40	17	74
1.1	9	40	15	64
1.48	13	40	16	69
2.27	12	30	12	54
3.12	11	30	10	51
6.15	17	20	7	44
8.1	6	40	6	52
10.2	3	30	6	39
12.0	10	20	6	36
14.5	1	40	5	46
66.0	17	0	6	23
88.0	13	0	9	22
98.0	2	20	10	32

TABLE II

Maximum CW E-I Readings Taken With an NF-105 at the DPIF #2 And Their Corresponding Field Intensity Levels.

Frequency (megacycles)	Meter Reading (db above 1 microvolt)	Meter Attenuation (db)	Correction Factor (db)	E (db above 1 microvolt/meter)
5.8	14	20	8	42
6.4	19	20	7	46
60.5	12	20	5	37
66.0	14	20	6	40
103.0	17	20	10	47
865.0	13	20	31	64
885.0	16	20	32	68

TABLE III

Maximum CW E-I Readings Taken With an NM-20B at the DPIP #2 and Their Corresponding Field Intensity Levels.

Frequency (megacycles)	Meter Reading (db above 1 microvolt)	Meter Attenuation (db)	Correction Factors (db)	E (db above 1 microvolt/meter)
.3	22	20	6	48
.545	30	0	6	36
.585	36	0	6	42
.645	22	20	6	48
.81	31	20	6	57
.96	22	40	6	68
1.09	38	0	6	44
1.25	31	0	6	37
1.48	38	0	6	44
4.01	30	20	6	56
9.35	27	0	6	33
10.6	26	0	6	32
15.6	36	0	6	42
17.5	40	0	6	46
20.9	35	0	6	41
21.6	31	0	6	37

TABLE IV

Maximum Broadband R-I Readings Taken With an NF-105 at the NPIF #1 and Their Corresponding Field Intensity Levels

Freq. (MC)	Total Imp. Gen. Input (db above 1 microvolt/MC)	Correction Factor (db)	Voltage (db above 1 micro-volt/MC/m	Bandwidth Correction Factor (db)	Equivalent CW voltage (db above 1 microvolt/m
.015	65	26 + 29	120	55	65
.02	66	26 + 26	118	54	64
.025	69	26 + 24	119	54	65
.03	47	26 + 27	100	53	47
.05	84	26 + 18	128	53	75
.065	44	26 + 22	92	54	38
.105	53	26 + 16	95	54	41
.15	69	26 + 19	114	54	60
.25	47	26 + 18	91	38	53
.35	115	26 + 18	159	37	122
.4	60	26 + 12	98	39	59
.54	56	26 + 12	94	37	57
.6	50	26 + 13	89	38	51
.8	60	26 + 15	101	34	67
.9	72	26 + 12	110	38	62
1.0	108	26 + 11	145	38	107
1.85	98	26 + 12	136	33	103
2.5	93	26 + 5	124	29	95
3.4	43	26 + 4	73	31	42
4.8	37	26 + 6	69	30	39
6.0	52	26 + 1	79	31	48
7.5	29	26 + 0	55	31	24
8.0	51	26 + 0	77	31	46
9.0	33	26 + 0	59	32	27
16.0	45	26 - 3	68	33	35
20.0	52	26 - 3	75	31	44
30.0	48	- 1	47	19	28
45.0	52	2	54	18	36

(Continued)

TABLE IV (continued)

Freq. (MC)	Total Imp. Gen. Input (db above 1 microvolt/MC)	Correction Factor (db)	Voltage (db above 1 micro-volt/MC/m	Bandwidth Correction Factor (db)	Equivalent CW voltage (db above 1 microvolt/m
50.0	84	3	87	18	69
60.0	51	5	56	18	38
70.0	56	6	62	19	43
83.0	37	8	45	18	27
90.0	45	9	54	19	35
130.0	54	11	65	19	46
200.0	45	16	61	11	50
300.0	36	20	56	10	46

TABLE V

Maximum Broadband R-I Readings Taken with an NF-105 at the DPIF #2 and Their Corresponding Field Intensity Levels

Freq. (MC)	Total Imp. Gen. Input (db above 1 microvolt/MC)	Correction Factor (db)	Voltage (db above 1 microvolt/MC/m	Bandwidth Correction Factor (db)	Equivalent CW voltage (db above 1 microvolt/m
.015	57	26 + 29	112	55	57
.02	58	26 + 26	110	54	56
.025	61	26 + 24	111	54	57
.036	53	26 + 26	105	53	52
.05	94	26 + 19	139	53	66
.06	58	26 + 16	100	53	46
.075	53	26 + 22	101	54	47
.11	50	26 + 15	91	54	37
.15	50	26 + 11	87	54	33
.37	108	26 + 14	148	40	108
.6	47	26 + 13	86	38	48
1.0	92	26 + 11	129	38	91
6.0	44	26 + 2	72	31	41
9.0	52	26	78	32	46
10.0	76	26	102	33	69
60.5	53	5	58	18	40
83.0	41	8	49	19	30

TABLE VI

Maximum Broadband E-I Readings Taken With an NM-20B at the DPIF #2 and Their Corresponding Field Intensity Levels.

Freq. (MC)	Meter Reading (db above 1 microvolt)	Meter Attenuation (db)	Correction Factor (db)	Voltage (db above 1 micro-volt/MC/m	Bandwidth Correction Factor (db)	Equivalent CW Voltage (db above 1 microvolt/M
.2	20	0	53 + 6	79	47	32
.25	20	0	53 + 6	79	47	32
.52	32	0	52 + 6	90	48	42
.7	19	0	50 + 6	75	46	29
.75	37	0	52 + 6	95	46	49
.82	36	0	50 + 6	92	43	49
.9	17	0	50 + 6	73	44	29
1.85	20	40	50 + 6	116	42	74
2.5	16	0	49 + 6	71	42	29
3.8	11	0	53 + 6	70	42	28
4.5	17	0	49 + 6	72	44	28
7.5	16	0	49 + 6	71	44	27
8.0	16	0	49 + 6	71	44	27
15.0	22	0	43 + 6	71	44	27
20.0	32	0	63 + 6	101	44	57
25.0	14	0	43 + 6	63	44	19

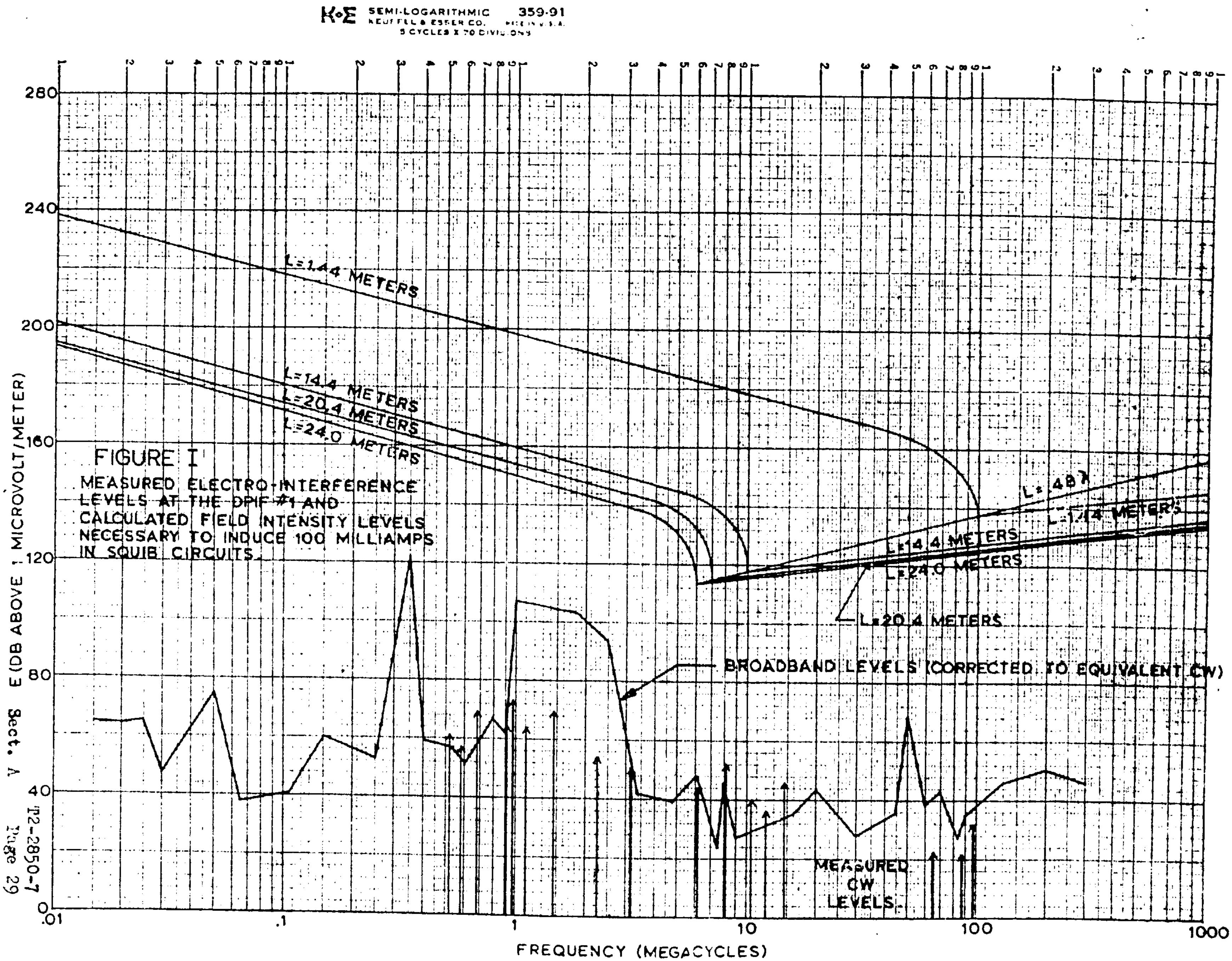

FIGURE I
MEASURED ELECTRO-INTERFERENCE LEVELS AT THE DPIF #1 AND CALCULATED FIELD INTENSITY LEVELS NECESSARY TO INDUCE 100 MILLIAMPS IN SQUIB CIRCUITS.

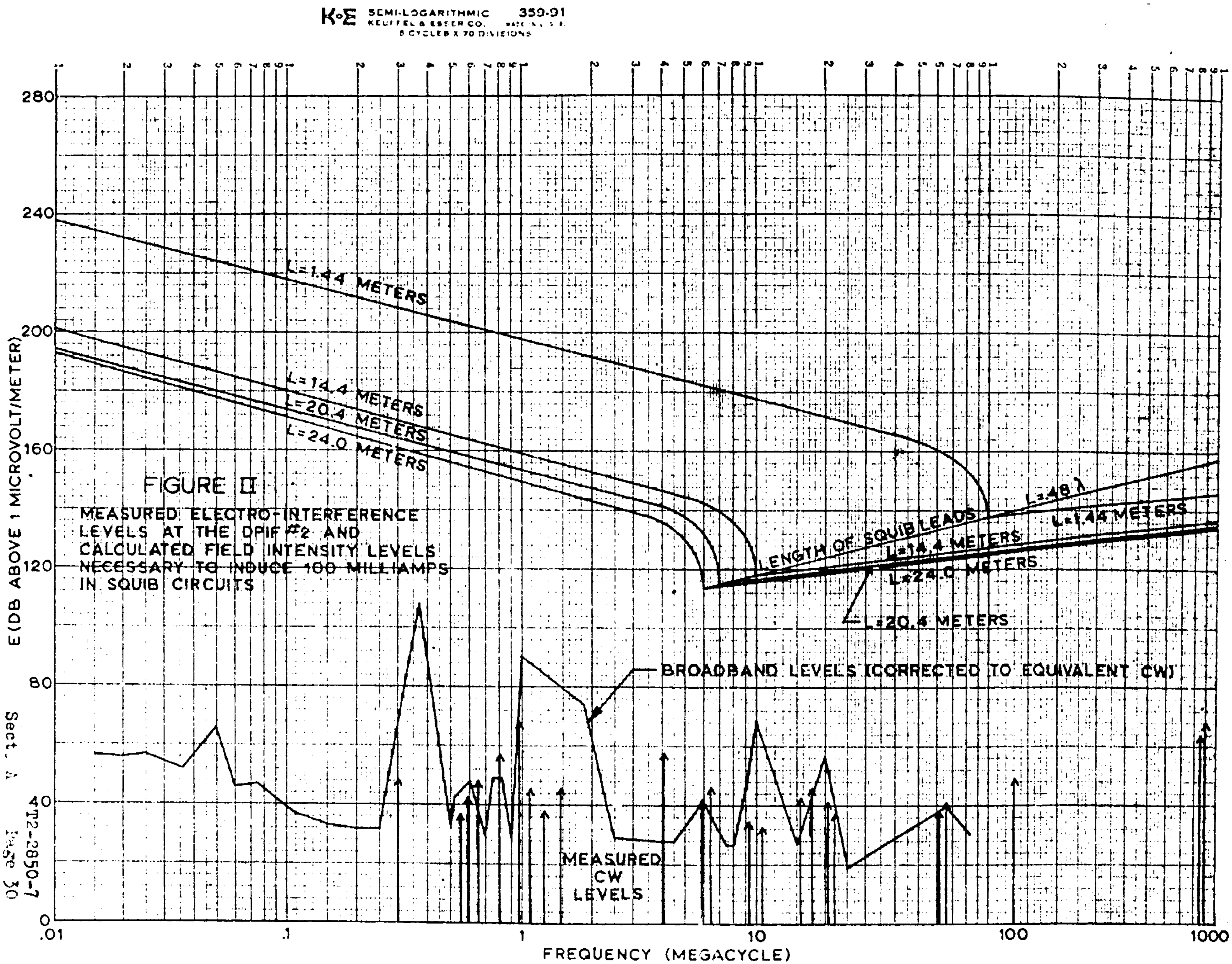

FIGURE II

MEASURED ELECTRO-INTERFERENCE LEVELS AT THE DPIF #2 AND CALCULATED FIELD INTENSITY LEVELS NECESSARY TO INDUCE 100 MILLIAMPS IN SQUIB CIRCUITS

4.0 CONCLUSIONS

As a result of the analysis contained in this document it has been determined that the ambient electric fields present in DPIF#1 and DPIF#2 are not of sufficient amplitude to induce 100 milliamperes in missile squib circuitry. The graphs of Figures I and II indicate that the measured electric fields are at least 37 db below the levels required to induce 100 milliamperes into these circuits.

Since this analysis is based on several "worst case" assumptions, the margin of safety is even greater than the indicated 37 db. Squib leads are shielded, twisted and located near missile metallic structures. Ignoring the attenuation afforded by the twisting of the leads and their proximity to metallic structures, the shielding alone will attenuate signals more than 35 db in the frequency range of 300 KC to 3 MC (See Reference 12, Sprague Technical Paper No. 62-1). At the maximum squib lead length of approximately 21 meters, an additional margin of safety of approximately 40 db exists because the squibs are located at the ends of pairs of leads instead of at the centers of dipoles as assumed (See Reference 11, Electric Transmission Lines).

The additional 20 db between 100 milliamperes and the squib design requirements of "one ampere no-fire" and other "worst case" assumptions provide a safety margin far greater than 100 db.